XVI. *The Life History of* Pseudacraea eurytus hobleyi, *Neave.* By G. D. H. Carpenter, B.A., B.M., (Oxon.), F.E.S.

[Read November 6th, 1912.]

When I came out to Uganda as a member of the Royal Society's Sleeping Sickness Commission, I obtained permission from the Society to send the Lepidoptera which I might collect to Prof. Poulton; and it is to frequent correspondence with him that the following interesting result is due, which confirms the suggestion made by Dr. Karl Jordan that several forms of *Pseudacraea*, hitherto regarded as distinct species, would be found to be only polymorphic forms of one species.

At the beginning of 1912 my investigations into the bionomics of *Glossina* took me to Bugalla, one of the Sesse Islands—a group lying in the N.W. corner of the great Lake Victoria, some twenty-five miles S.W. of Entebbe. Here I soon found that *Pseudacraeae* of the three forms *terra*, *hobleyi*, and *obscura*, together with intermediate forms, were extremely abundant; *terra* being more numerous than the other two put together. Everything was favourable for testing Dr. Jordan's suggestion. I obtained many females in succession, and put them in a large box with gauze front, hoping they would oviposit on the leaves which I put in; but none would lay. I was not at this time aware of the specific food-plant, and had not been able to find the food-plant of *Pseudacraea lucretia* which Prof. Poulton suggested would probably be the food-plant of the *hobleyi* forms. Thinking that the atmospheric conditions in my hut, on top of an open grassy hill about 150 feet above the lake, were not suited to the forest-loving butterflies, I took the box down into the forest in which the Pseudacraeas fly, and stood it on supports in a large basin of water. Still the Pseudacraeas would not lay, and I was beginning to despair. However, on Sunday, June 16th, 1912, in the forest on the lake shore, I saw a *Pseudacraea* which I had been following about, and vainly trying to catch, settle on the under surface

of a leaf of a sapling, remain motionless, hanging from it with wings closed, and then fly away quickly. On looking at the leaf, to my intense pleasure, I found an egg on the middle of the under surface, still glistening with the secretion affixing it to the leaf, and of a dull yellow colour.

Let me here briefly state the main facts of the life-history. The *parent* was one of the intermediate forms so plentiful in the locality, being an "*obscura*" with large pale areas, and a reddish suffusion strongly marked on the under surface of the base of the hindwing, indicating an admixture of the "*hobleyi*" form.

The egg was laid on June 16.
The egg hatched. June 25.
1st larval ecdysis. July 1.
2nd do. July 7.
3rd do. July 14.
4th do. July 21.
Larva pupated. August 1.
Imago emerged. August 16.
The imago was *a male, of the form "terra."*

This in itself was sufficient to prove the identity of the forms "*obscura*," "*hobleyi*" and "*terra*." Further, the larva and pupa corresponded exactly with the coloured drawings of those of *Ps. imitator*, Trim., as drawn by Miss Margaret E. Fountaine, and published in the Transactions of the Ent. Soc., Part I, 1911 (pp. 57–59, and Pl. X), thus bringing this form into the same category. Miss Fountaine, however, makes no mention of the great difference in the appearance and habits of the young larva before and after the first ecdysis.

I will now proceed with the detailed description of the various stages.

The Ovum.—When freshly deposited on the 16th June, at noon, was of a uniform dull yellow colour. In shape it was spherical, but slightly flattened at point of attachment to the leaf: the surface being of a shagreen texture and deeply sculptured into hexagonal cells. On June 18th the periphery became clearer and less yellow, the centre opaque and dull pinkish. On the 24th the centre became black, and the outer parts white and semi-transparent.

The Larva.—Finally, without further change in the appearance of the ovum, at 9.15 a.m. on June 25th the young larva ate its way through the shell, and at once set

to work to consume the rest, which it accomplished in half an hour. The larva was rather "maggotty looking," being of a dull greenish white, and quite smooth, with no processes whatsoever on body or head, which was smooth shining black. In a very short while the larva took up its position along the edge of the leaf: and within a few hours, before it had eaten any of the leaf, had affixed to its back one or two pellets of excrement. The way in which it subsequently ate the leaf was interesting. It ate a small hole out of the edge, and then continued this down the side of a lateral rib of the leaf, subsequently doing the same on the other side of the rib, which was cut out from the rest of the leaf tissue but attached by its base. On this bare rib the young larva rested, and very soon had accumulated a large number of light brown pellets of excrement on its back and on the leaf around it. It always returned to rest at the same spot after feeding.

First Ecdysis.—The first ecdysis occurred on July 1st, with a complete change in appearance and habits. The larva no longer covered itself with pellets; and the appearance it took on persisted until after the fourth ecdysis; the characters acquired at the first being merely accentuated by the second and third ecdyses. The description of the larva after the third ecdysis is as follows. (See also Miss Fountaine's drawing.)

From first to fourth Ecdysis. Dorsally.—From behind the third segment to the posterior margin of the tenth, of the same green hue as the leaf, bordered with a pale brownish lateral line. Along this line, from each segment arises a spine, beset with smaller spines. The former are quite small except on segments two, three, eleven, and twelve, while that on segment two is the largest of all, and the pair diverge outwards and forwards like antlers, reaching the level of the front of the head. The pair on the third segment is similar but smaller. On segments two and three the dorsal green colour is much marked by pale brown areas continued inwards and backwards from the bases of the "horns" to meet mid-dorsally, making the hinder sides of a triangular area whose base is formed by a similar line extending transversely between the bases of the "horns." The first segment, dorsally, is mostly blackish, with a narrow antero-posterior mid-dorsal white line.

Posteriorly, there are two more pairs of enlarged spines, those on the eleventh segment being a little larger than those in the middle

of the body; and those on the twelfth midway in size between those of the second and third segments, and curved upwards and forwards. The colouring of the last two segments dorsally is ashy grey, dotted and mottled with blackish.

Laterally.—From behind the head until the eighth segment the larva is greenish black, but on the eighth segment this is bevelled off and gradually replaced by ashy grey, which is continued to the end of the body and there becomes continuous with the same colour dorsally. On the seventh segment the dark colour is interrupted by a large, raised, triangular whitish flap, with its base at the lateral line, and its apex running on to the base of the clasper, and there ending in a spine which points almost directly outwards at right angles to the body. There is a similar, dark, spine, on the base of the clasper of the seventh segment.

Head.—Greenish black, slightly bifid at top, beset with numerous small white spines. A narrow whitish band bordered with blackish starts on each side of mid-line at the crown, nearly meets its fellow in the middle of the front of the head, and curves away again below.

As regards its *habits* the larva has the same "homing" instinct as when much younger, always resting at the tip of a bare rib, and returning there after feeding. In the resting position the head and first five segments are raised off the leaf, and also all that part of the body behind the fourth pair of claspers, this being held up at quite a sharp angle, thus bringing more into evidence the lateral ashy colour of that part of the body. The larva is very sluggish and rarely moves except in connection with feeding.

The fourth Ecdysis.—This took place on July 21st and brought great change in appearance. The general colour was now a velvety purplish brown, and under a lens the whole integument was seen to be finely dusted with minute green dots. Here and there the purplish tint was replaced by greenish mottling. The flap on the side of the 7th segment, and the formerly grey area behind it, now became light pinkish brown, and just anterior to the flap were two raised circular dots of pure white. The first segment still bore a short white mid-dorsal line. With this ecdysis the spinous processes are considerably developed, those on segments four to nine, inclusive, being trifid at the extremity, the central prong slightly the largest. The pair on the second segment are even larger

than before, very thick, slightly flattened at the extremity, and are set with minute spines along the edges. They diverge upwards and outwards, and then turn forwards at an angle. The spines on the third segment are only a little larger than those on the middle segments.

The processes on the tenth segment are a little larger than those on the third, and flattened from side to side. The last pair of processes (on eleventh segment) are very large, and almost leaf-like, owing to the great flattening from side to side: the anterior and posterior edges have a frayed appearance, owing to their being set with small spines close together. These processes curve forwards and upwards.

The *head* is very spiny, ash-coloured in front, dark brown at sides.

Pupation.—On July 29th the larva spent the day curled up on a leaf eating nothing, and on the evening of the 30th suspended itself by the last pair of claspers from the tip of a leaf. On the 1st August, very early in the morning, before daybreak, it pupated. After this first experience I have reared numbers of these larvae, and it is very interesting to note that the preparations for pupation always occur in the same way. During one night, after remaining motionless in a curled-up posture on the leaf for some twelve hours, the larva will suspend itself from the leaf tip; and pupation takes place during the next night. Presumably by this adaptation the pupa gains by not being exposed to daylight till the protective green colour is fully developed, which takes some hours. The pupa corresponded exactly with the figure and description of that of *Ps. imitator* (loc. cit.), save only that the long processes from the head were not twisted but quite straight and parallel to each other.

The pupa in colour was leaf green, but the lower surface of the dorsum, and head, was slightly tinted with a light bluish grey bloom, as if to neutralise shadow. From the top of the head project a pair of flattened stalk-like processes, soldered together along adjacent edges except at the extreme tips, which are square. These processes immediately after the shedding of the larval skin are separate from each other, short, and curved dorsally. They appear to be straightened out to their final position and shape by the forcing into them of fluid, and the triangular processes on the abdomen are similarly distended, being very small at first. The cephalic

processes are about one-third of the length from top of head to end of abdomen. They make a large obtuse angle with the ventral surface of the body, but are in the same longitudinal plane. The body is very much flattened from side to side: each abdominal segment is slightly ridged in the mid-ventral line, the edge of the ridge being outlined in dark brown. From the dorsal surface of the abdomen project two large triangular processes, very thin from side to side, with edges outlined in dark brown. One, near the tip of the abdomen, is only half the size of that arising from the base of the abdomen, which has on its posterior edge a secondary triangular eminence.

Emergence of the Imago.—On Aug. 13 the antennae and limbs became very distinct through the pupal skin, and on Aug. 15 two dark patches showed on the forewing. These dark areas were the future tawny areas on the forewing of the imago, and soon assumed that colour, the rest of the wing then becoming black. On the morning of the 16th I was able to see how the wings were separated from the pupal skin by the secretion of air between the two, and very shortly the imago emerged; a male of the form hitherto described as a distinct species under the name *Pseudacraea terra*, Neave.

The fortunate observation that showed me the food-plant has enabled me to recognise it in the forest: it is the tree which serves as food for *Ps. lucretia*, but I have been unable to get full botanical specimens of flower, etc., for identification. I have now had no difficulty in getting captive females to oviposit on food-plant in the box in the forest, and up to the time of writing have secured one or more ova from six females of all three forms. The young larvae are rather delicate, and sometimes exhaust themselves so much by wandering about, spinning a silk foothold as they go, that they are unable to eat the hard dry leaf, and die. I have lost some of each brood save one, from this cause. Of one brood of four which all hatched on one day, the members all seemed equally thriving, when one, for some reason unknown, ceased feeding and shrivelled up. The food-plant being so dry, has to be renewed every other day, in spite of being kept in water. In spite of these disappointments, however, I hope to provide Prof. Poulton with specimens of each form reared from the other.

August 1912.

APPENDIX.

[I have thought it well to add to this paper an account of specimens subsequently bred by Dr. Carpenter from three known females of the *obscura* form. All three were captured in the neighbourhood of Dr. Carpenter's camp on the east side of the centre of Bugalla Island. Having had the opportunity of comparing the whole of the "set" material, I have added a few notes to Dr. Carpenter's descriptions of the three parents and their offspring, but it has not been deemed necessary to indicate the slight additions.—E. B. Poulton.]

Series B.—Parent *obscura*, captured in the forest just above lake level, June 30, 1912 (laid four eggs).

Hatched.	1st Moult.	2nd.	3rd.	4th.	Pupated.	Imago.
1. July 12	July 20	July 26	Aug. 1	Aug. 7	Aug. 18	Sept. 3
2. July 12	July 21	July 26	Aug. 1	Aug. 9	Aug. 21	Sept. 6
3. July 13	July 21	July 26	Aug. 2	Aug. 10	Aug. 23	Sept. 8

Remarks.—The female parent has a pronounced pale forewing bar and the hindwing towards the base is paler than usual. The umber brown marking on the hindwing under surface is rather more developed than is usual in *obscura*.

1 is a ♀ *terra* with pale fulvous forewing bar which on the under side is nearly white.

2. A particularly interesting ♀ specimen. I do not think I have caught one quite like it. It would *take very little to make it into imitator*. The subapical bar is white, the inner marginal forewing pale area is very faintly marked, and a very little would cause it to disappear altogether; and to make the hindwing like *imitator* you only want a concentration of the pale colour into a band. The specimen bears much resemblance to the female parent, differing in the more pronounced forewing bar and the less pronounced pale areas on the rest of the expanse of both wings.

3. A ♀ *terra*, with rather more white suffusion on the forewing bar than in 1.

Traces of the umber marking appear in all three offspring, faintly in 1 and 3, distinct in 2 which resembles the parent in this respect.

Series C.—Parent a pale *obscura*, captured in the forest just above lake level, July 9, 1912 (only laid one egg, on July 9).

Hatched.	1st Moult.	2nd.	3rd.	4th.	Pupated.	Imago.
July 17	July 24	July 30	Aug. 4	Aug. 10	Aug. 22	Sept. —

Remarks.—The parent is more worn than B, but apparently the chief pale area of both wings was much less pronounced than in the latter. The basal area of hindwing under surface is free from the umber brown marking.

1. Imago a ♂ *obscura* tending in the direction of *terra*. No umber marking on under surface.

Series D.—Parent *obscura-hobleyi*, captured on flowers at the edge of the forest, July 15, 1912 (laid 13 ova).

One egg shrivelled, one failed to hatch, one larva died before first moult, another was a "wanderer" and died from exhaustion, another died during first moult and one after. Result seven pupae only.

Hatched.	1st Moult.	2nd.	3rd.	4th.	Pupated.	Imago.
1. July 25	July 30	Aug. 4	Aug. 9	Aug. 15	Aug. 26	Sept. 10
2. July 25	July 30	Aug. 4	Aug. 9	Aug. 16	Aug. 28	Sept. 11
3. July 26	July 31	Aug. 4	Aug. 10	Aug. 16	Aug. 28	Sept. 12
4. July 26	July 31	Aug. 5	Aug. 10	Aug. 17	Aug. 29	Sept. 13
5. July 27	Aug. 1	Aug. 9	Aug. 14	Aug. 26	Sept. 4	Sept. 20
6. July 28	Aug. 4	Aug. 11	Aug. 17	Aug. 26	Sept. 6	Sept. 21
7. July 28	Aug. 5	Aug. 12	Aug. 20	Aug. 29	Sept. 7	Sept. 23

Remarks.—The parent is worn like C, but its pale areas had been apparently much like those of B, showing like the latter a tendency towards the female *hobleyi* in the emphasis of the white bar. The umber marking is present, but faded, and it is difficult to estimate the original development of this marking.

1. ♀ *terra* tending towards *hobleyi* ♀ in the paleness of all the forewing markings, especially on the under surface (where they are white), in the distinct umber marking on the under surface and the traces of a white bar along its outer margin.

2. ♀ *terra* with a trace of *obscura*. The umber marking barely visible.

3. ♀ *terra* with white forewing subapical bar. In this and the umber marking and the white areas on the under

surface of the forewing this specimen exhibits the same tendencies as 1.

4. ♀ *terra*, dark, with faintest trace of *obscura*; very similar to 2.

5. ♂ *obscura*, much like C 1, but tending rather more strongly in the direction of *terra*. Umber marking barely visible.

6. ♀ similar to 5, only tending rather more strongly towards *terra* on the hindwing upper surface.

7. ♂ similar to 5, but tending slightly more strongly towards *terra*. *Sept. 21, 1912.*

[The two families tabulated below, together with the notes upon them, were received in a letter from Dr. Carpenter, dated October 17, 1912.]

Series E.—Female parent a typical ♀ *hobleyi*, captured at the edge of the forest, July 24, 1912.

Hatched.	1st Moult.	2nd.	3rd.	4th.	Pupated.	Imago.
1. Aug. 4	Aug. 11	Aug. 17	Aug. 27	Sept. 2	Sept. 14	Sept. 28
2. Aug. 4	Aug. 11	Aug. 20	Sept. 2	Sept. 9	Sept. 21	Oct. 4
3. Aug. 4	Aug. 13	Aug. 21	Sept. 3	Sept. 11	Sept. 22	Oct. 6

Remarks.—1. A typical (dwarfed) ♀ *hobleyi*.

2. ♀, approach to *imitator* like B 2.

3. ♂, a combination of *hobleyi*, *terra* and *obscura*, showing early stage towards No. 2.

The *hobleyi* influence is shown in both 2 and 3 by the strong development of the umber triangle on the hindwing under surface.

Two other ova shrivelled up without hatching.

Series F.—Female parent a typical *terra*, captured Aug. 2, at the edge of the forest.

Hatched.	1st Moult.	2nd.	3rd.	4th.	5th.	Pupated.	Imago.
Aug. 11	Aug. 25	Sept. 1	Sept. 7	Sept. 14	Sept. 23	Oct. 4	Oct. 18

Remarks.—For some reason this larva grew slowly and put in an extra ecdysis on Sept. 23 (the 5th). The butterfly is a typical ♂ *terra*, except for the presence of a strongly marked indication of the umber triangle. The female parent was cut to pieces by ants which got into the cage, but the wings show no trace of the umber marking.

Series G.—Female parent a typical ♀ *hobleyi*, captured on flowers at the edge of the forest, Aug. 6, 1912.

Hatched.	1st Moult.	2nd.	3rd.	4th.	Pupated.	Imago.
1. Aug. 17	Aug. 26	Sept. 1	Sept. 8	Sept. 14	Sept. 25	Oct. 9
2. Aug. 18	Aug. 27	Sept. 1	Sept. 8	Sept. 15	Sept. 26	Oct. 10
3. Aug. 18	Aug. 27	Sept. 1	Sept. 8	Sept. 16	Sept. 27	Oct. 11
4. Aug. 18	Aug. 27	Sept. 2	Sept. 8	Sept. 16	Sept. 27	Oct. 11
5. Aug. 18	Aug. 27	Sept. 2	Sept. 8	Sept. 16	Sept. 27	Oct. 11
6. Aug. 18	Aug. 27	Sept. 3	Sept. 8	Sept. 16	Sept. 27	Oct. 12

Remarks.—No. 2 a typical ♂ *hobleyi*. All the others typical female *hobleyi* except No. 4 and No. 6, in which the white bar of the hindwing is continued on to the forewing so as to meet, or nearly meet, the subapical white bar. This latter feature is seen in the parent.

There were, alas, *seven* other eggs, but six young larvæ died soon after hatching, one as a result of 3rd moult. All the survivors were pure *hobleyi*. 5 ♀ ♀, 1 ♂.

From the results I have obtained so far, it appears that form *hobleyi* has a very strong influence and it is *the most distinct form* (*dominant* in the *non*-Mendelian sense). Let me tabulate the following reasons.

I. An *enormous* number of otherwise more or less typical *terra* and *obscura* have a reddish tint at base of the hindwing under surface, and this applies still more to a large number of intermediates strongly tinted with *hobleyi*.

II. But though *terra-hobleyi*, and *obscura-hobleyi* are common enough, yet I have not yet, so far as I am aware, *sent you a single specimen* of *hobleyi-terra* or *hobleyi-obscura*—i. e. a form which you could say was *hobleyi* tainted with *obscura* or *terra*.

III. I have *not bred a pure hobleyi from terra or obscura.*

IV. Lastly (which seems most important) from two *hobleyi* parents I have bred, on the one hand, in series E, a typical *hobleyi* and two intermediates (no typical *terra* or *obscura*), on the other, in series G, six offspring, of which *not one was anything but typical hobleyi*! This seems extremely interesting, and I suppose indicates that *hobleyi* is the longest established form in Uganda at any rate.

I should, a day ago, have said that I supposed *hobleyi* had nearly become a true species—but yesterday I read Dr. Jordan's paper, and at the end he dealt with this very fallacy!

So *hobleyi* seems dominant over both *terra* and *obscura*; the former of the last two being also stronger than the latter. *Hobleyi*, thus, is the most interesting form to breed from, and I have now got another in confinement.